What is claimed is:

1. A plasma processing method comprising the steps of:

preparing a process subject having an organic layer on a surface thereof; and

irradiating the process subject with H_2 plasma to improve plasma resistance of the organic layer.

2. The plasma processing method according to claim 1, wherein the organic layer is a mask layer.

3. The plasma processing method according to claim 2, wherein the mask layer is a photoresist layer.

4. The plasma processing method according to claim 3, wherein the photoresist layer is made of an ArF photoresist or F2 photoresist.

5. A plasma processing method comprising the steps of:

preparing a process subject having an organic layer on a surface thereof; and

irradiating the process subject with plasma of a process gas containing H_2 and an inert gas, to improve plasma resistance of the organic layer.

6. The plasma processing method according to claim 5, wherein the organic layer is a mask layer.

7. The plasma processing method according to claim 6, wherein the mask layer is a photoresist layer.

8. The plasma processing method according to claim 7, wherein the photoresist layer is made of an

ArF photoresist or F2 photoresist.

9. The plasma processing method according to claim 5, wherein the process gas contains N_2.

10. A plasma processing method comprising the steps of:

preparing a process subject having an organic layer on a surface thereof; and

irradiating the process subject with plasma of a process gas containing a substance having H and an inert gas, to improve plasma resistance of the organic layer.

11. The plasma processing method according to claim 10, wherein the organic layer is a mask layer.

12. The plasma processing method according to claim 11, wherein the mask layer is a photoresist layer.

13. The plasma processing method according to claim 10, wherein the substance having H is NH_3.

14. The plasma processing method according to claim 10, wherein the process gas contains N_2.

15. A plasma processing method comprising the steps of:

preparing a process subject having a photoresist layer made of an ArF photoresist or F2 photoresist on a surface thereof; and

irradiating the process subject with plasma of a process gas containing a substance having H, to improve plasma resistance of the photoresist layer.

16. The plasma processing method according to claim 15, wherein the substance having H is H_2.

17. The plasma processing method according to claim 15, wherein the substance having H is NH_3.

18. The plasma processing method according to claim 15, wherein the process gas contains N_2.

19. The plasma processing method according to claim 15, wherein the step of irradiation with plasma is performed in an atmosphere having a pressure of 13.3 Pa (100 mTorr) or less.

20. The plasma processing method according to claim 19, wherein the step of irradiation with plasma is performed in an atmosphere having a pressure of 1.1 to 4.0 Pa (8 to 30 mTorr).

21. The plasma processing method according to claim 19, wherein the process subject has an etching objective layer below the photoresist layer, the photoresist has an opening pattern, and the method comprises a step of plasma-etching the etching objective layer through the opening pattern of the photoresist layer after the plasma irradiation.

22. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, and an organic layer covering the etching objective portion and having an opening pattern formed

therein;

turning a process gas containing a substance having H into plasma in the process container, and irradiating the organic layer with the plasma; and

turning an etching gas into plasma in the process container, and etching the etching objective portion through the opening pattern.

23. The plasma processing method according to claim 22, wherein the substance having H is H_2.

24. The plasma processing method according to claim 22, wherein the substance having H is NH_3.

25. The plasma processing method according to claim 22, wherein the process gas contains N_2.

26. The plasma processing method according to claim 22, wherein the organic layer is a mask layer.

27. The plasma processing method according to claim 26, wherein the mask layer is a photoresist layer.

28. The plasma processing method according to claim 27, wherein the photoresist layer is made of an ArF photoresist or F2 photoresist.

29. The plasma processing method according to claim 22, wherein the process gas and the etching gas are the same gas.

30. The plasma processing method according to claim 22, wherein the etching gas is a gas formed of the process gas and another gas added thereto.

31. The plasma processing method according to

claim 22, wherein the etching objective portion is an SiO_2 layer.

32. The plasma processing method according to claim 31, wherein the etching gas is a gas containing C_5F_8.

33. The plasma processing method according to claim 22, wherein the step of irradiation with plasma is performed in an atmosphere having a pressure of 13.3 Pa (100 mTorr) or less.

34. The plasma processing method according to claim 33, wherein the step of irradiation with plasma is performed in an atmosphere having a pressure of 1.1 to 4.0 Pa (8 to 30 mTorr).

35. A plasma processing method comprising the steps of:

preparing a process subject having a photoresist layer made of an ArF photoresist or F2 photoresist on a surface thereof; and

irradiating the process subject with plasma of a process gas containing a substance having N, to improve plasma resistance of the photoresist layer.

36. The plasma processing method according to claim 35, wherein the substance having N is N_2.

37. The plasma processing method according to claim 35, wherein the substance having N is NH_3.

38. The plasma processing method according to claim 35, wherein the process gas contains a substance

having H.

39. The plasma processing method according to claim 38, wherein the substance having H is one or more selected from the group consisting of H_2, CHF_3, CH_2F_2, and CH_3F.

40. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the antireflective layer, and having an opening pattern formed therein;

supplying a process gas into the process container;

turning the process gas into plasma; and

causing the plasma to act on the process subject to improve plasma resistance of the photoresist layer, and to etch the antireflective layer through the opening pattern.

41. The plasma processing method according to claim 40, wherein the process gas contains H_2.

42. The plasma processing method according to claim 41, wherein the process subject is placed on a susceptor disposed in the process container, and, in the step of causing the plasma to act on the process

subject, the susceptor is supplied with a high-frequency power having a frequency of 100 MHz or more, and a high-frequency power having a frequency of 3 MHz or more.

43. The plasma processing method according to claim 42, wherein the high-frequency power having a frequency of 3 MHz or more is set at 100W or less.

44. The plasma processing method according to claim 41, wherein the process gas is H_2.

45. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, an antireflective layer covering the etching objective layer, and a mask layer covering the antireflective layer and having an opening pattern formed therein;

supplying a process gas containing H_2 into the process container;

turning the process gas into plasma; and

selectively etching the antireflective layer relative to the mask layer by the plasma, through the opening pattern of the mask layer.

46. The plasma processing method according to claim 45, wherein the process subject is placed on a susceptor disposed in the process container, and, in the etching step, the susceptor is supplied with a

high-frequency power having a frequency of 100 MHz or more, and a high-frequency power having a frequency of 3 MHz or more, in a superimposition manner.

47. The plasma processing method according to claim 46, wherein the high-frequency power having a frequency of 3 MHz or more is set at 100W or less.

48. The plasma processing method according to claim 45, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

49. The plasma processing method according to claim 45, wherein the process gas is H_2.

50. The plasma processing method according to claim 49, further comprising, after the step of etching the antireflective layer, a step of turning CF_4 and H_2 into plasma, and etching halfway the etching objective layer through the opening pattern of the mask layer, and a step of turning an etching gas into plasma, and etching a remaining portion of the etching objective layer, following the step of etching halfway.

51. The plasma processing method according to claim 50, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

52. The plasma processing method according to claim 50, wherein the mask layer is made of a methacrylate resin.

53. The plasma processing method according to claim 50, wherein the etching gas is a gas other than a

mixture gas of CF_4 and H_2.

54. The plasma processing method according to claim 50, wherein the etching objective layer is an SiO_2 layer, and the etching gas is a gas containing C_5F_8 and O_2.

55. A plasma processing method comprising:

a step of placing a process subject on a worktable, wherein the process subject has an etching objective layer, and a mask layer made of an ArF photoresist or F2 photoresist, covering the etching objective layer, and having an opening pattern formed therein;

an initial etching step of turning CF_4 and H_2 into plasma, and etching halfway the etching objective layer through the opening pattern of the mask layer; and

a main etching step of turning an etching gas containing a fluorocarbon into plasma, and etching the etching objective layer, following the initial etching step.

56. The plasma processing method according to claim 55, wherein the etching objective layer is an SiO_2 layer.

57. A plasma processing method comprising:

a step of placing a process subject on a worktable, wherein the process subject has an etching objective layer, an antireflective layer covering the etching objective layer, and a mask layer made of an acrylate resin, covering the antireflective layer, and having an

opening pattern formed therein;

a first etching step of turning CF_4 into plasma, and etching the antireflective layer through the opening pattern of the mask layer;

a second etching step of turning CF_4 and H_2 into plasma, and etching halfway the etching objective layer through the opening pattern of the mask layer; and

a third etching step of turning an etching gas containing a fluorocarbon into plasma, and etching the etching objective layer, following the second etching step.

58. The plasma processing method according to claim 57, wherein the etching objective layer is an SiO_2 layer.

59. A plasma processing method comprising the steps of:

placing a process subject on a susceptor disposed in a process container, wherein the process subject has an etching objective layer, and a mask layer covering the etching objective layer and having an opening pattern formed therein;

supplying a process gas containing H_2 into the process container;

supplying the susceptor with a high-frequency power having a frequency of 100 MHz or more, and a high-frequency power having a frequency of 3 MHz or more; and

setting a pressure in the process container at 13.3 Pa (100 mTorr) or less.

60. The plasma processing method according to claim 59, wherein the high-frequency power having a frequency of 3 MHz or more is set at 100W or less.

61. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the etching objective portion, and having an opening pattern formed therein;

turning a process gas containing a substance having N into plasma in the process container, and irradiating the photoresist layer with the plasma; and

turning an etching gas into plasma in the process container, and etching the etching objective portion through the opening pattern.

62. The plasma processing method according to claim 61, wherein the substance having N is N_2.

63. The plasma processing method according to claim 62, wherein the process gas contains H_2.

64. The plasma processing method according to claim 62, wherein the process gas contains one or more selected from the group consisting of CHF_3, CH_2F_2, and CH_3F.

65. The plasma processing method according to claim 61, wherein the substance having N is NH_3.

66. A plasma processing method comprising:

a step of placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the antireflective layer, and having an opening pattern formed therein;

a first etching step of turning a process gas containing a substance having N into plasma in the process container, and etching the antireflective layer through the opening pattern; and

a second etching step of turning an etching gas into plasma in the process container, and etching the etching objective portion through the opening pattern.

67. The plasma processing method according to claim 66, wherein the substance having N is N_2.

68. The plasma processing method according to claim 67, wherein the process gas contains H_2.

69. The plasma processing method according to claim 68, wherein the first etching step is performed with a pressure in the process container set at 107 to 160 Pa (800 to 1,200 mTorr).

70. The plasma processing method according to claim 69, wherein the etching objective layer is an SiO_2

layer, and the etching gas contains C_5F_8.

71. The plasma processing method according to claim 70, wherein the C_5F_8 is 1,1,1,4,4,5,5,5-octafluoro-2-pentyne.

72. The plasma processing method according to claim 67, wherein the process gas contains one or more selected from the group consisting of CHF_3, CH_2F_2, and CH_3F.

73. The plasma processing method according to claim 66, wherein the substance having N is NH_3.

74. The plasma processing method according to claim 66, wherein the etching objective layer is an SiO_2 layer, and the etching gas contains C_4F_6.

75. The plasma processing method according to claim 66, wherein the etching objective layer is an SiO_2 layer, and the etching gas contains C_5F_8.

76. The plasma processing method according to claim 75, wherein the C_5F_8 is a straight-chain C_5F_8.

77. The plasma processing method according to claim 76, wherein the straight-chain C_5F_8 is 1,1,1,4,4,5,5,5-octafluoro-2-pentyne.

78. The plasma processing method according to claim 75, wherein the process gas contains N_2 and H_2, and the first etching step is performed with a pressure in the process container set at 107 to 160 Pa (800 to 1,200 mTorr).

79. A plasma processing method comprising the

steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, and an organic mask layer covering the etching objective layer and having an opening pattern formed therein, and the process container includes a component with an exposed portion made of a substance having Si;

supplying a process gas of one or more selected from the group consisting of H_2, N_2, and He into the process container; and

turning the process gas into plasma, and plasma-processing the organic mask layer.

80. The plasma processing method according to claim 79, further comprising a step of etching the etching objective layer after the plasma process step.

81. The plasma processing method according to claim 79, wherein the organic mask layer is an organic photoresist layer.

82. The plasma processing method according to claim 81, wherein the organic photoresist layer is made of an ArF photoresist or F2 photoresist.

83. The plasma processing method according to claim 79, wherein the substance having Si is single-crystalline Si.

84. The plasma processing method according to claim 79, wherein the substance having Si is SiC.

85. The plasma processing method according to

claim 79, wherein the component with an exposed portion made of a substance having Si is a counter electrode disposed in the process container to face the process subject.

86. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, an organic film covering the etching objective layer, and an organic mask layer covering the organic film and having an opening pattern formed therein, and the process container includes a component with an exposed portion made of a substance having Si;

supplying an etching gas into the process container;

turning the etching gas into plasma, and etching the organic film through the opening pattern of the organic mask layer;

supplying a process gas of one or more selected from the group consisting of H_2, N_2, and He into the process container; and

turning the process gas into plasma, and plasma-processing the organic mask layer.

87. The plasma processing method according to claim 86, wherein the etching gas contains CF_4.

88. The plasma processing method according to claim 86, further comprising a step of etching the

etching objective layer after the plasma process step.

89. The plasma processing method according to claim 86, wherein the organic film is an organic antireflective film.

90. The plasma processing method according to claim 86, wherein the organic mask layer is an organic photoresist layer.

91. The plasma processing method according to claim 90, wherein the organic photoresist layer is made of an ArF photoresist or F2 photoresist.

92. The plasma processing method according to claim 86, wherein the substance having Si is single-crystalline Si.

93. The plasma processing method according to claim 86, wherein the substance having Si is SiC.

94. The plasma processing method according to claim 86, wherein the component with an exposed portion made of a substance having Si is a counter electrode disposed in the process container to face the process subject.

95. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, an organic film covering the etching objective layer, and an organic mask layer covering the organic film and having an opening pattern formed therein, and

the process container includes a component with an exposed portion made of a substance having Si;

supplying H_2 into the process container; and

turning the supplied H_2 into plasma, and etching the organic film through the opening pattern of the organic mask layer.

96. The plasma processing method according to claim 95, further comprising a step of etching the etching objective layer after the step of etching the organic film.

97. The plasma processing method according to claim 95, wherein the organic film is an organic antireflective film.

98. The plasma processing method according to claim 95, wherein the organic mask layer is an organic photoresist layer.

99. The plasma processing method according to claim 98, wherein the organic photoresist layer is made of an ArF photoresist or F2 photoresist.

100. The plasma processing method according to claim 95, wherein the substance having Si is single-crystalline Si.

101. The plasma processing method according to claim 95, wherein the substance having Si is SiC.

102. The plasma processing method according to claim 95, wherein the component with an exposed portion made of a substance having Si is a counter electrode

disposed in the process container to face the process subject.

103. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the etching objective layer, and having an opening pattern formed therein;

supplying a process gas containing C_2F_4 into the process container accommodating the process subject;

turning the process gas into plasma; and

etching the etching objective layer on the process subject by the plasma of the process gas through the opening pattern of the photoresist layer.

104. The plasma processing method according to claim 103, wherein the etching objective layer is a carbon-containing layer.

105. The plasma processing method according to claim 103, wherein the etching objective layer is an organic layer.

106. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, and a mask layer covering the etching objective

layer and having an opening pattern formed therein;

supplying a process gas containing C_2F_4 and O_2 into the process container accommodating the process subject;

turning the process gas into plasma; and

etching the etching objective layer on the process subject by the plasma of the process gas through the opening pattern of the mask layer.

107. The plasma processing method according to claim 106, wherein the mask layer is a photoresist layer.

108. The plasma processing method according to claim 107, wherein the etching objective layer is an antireflective layer.

109. The plasma processing method according to claim 107, wherein the photoresist layer is made of an ArF photoresist or F2 photoresist.

110. The plasma processing method according to claim 106, wherein the etching objective layer is a carbon-containing layer.

111. The plasma processing method according to claim 106, wherein the etching objective layer is an organic layer.

112. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective

portion, an antireflective layer covering the etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the antireflective layer, and having an opening pattern formed therein;

turning an etching gas containing a substance having C and F and a substance having H into plasma in the process container, and etching the antireflective layer through the opening pattern; and

etching the etching objective portion.

113. The plasma processing method according to claim 112, wherein the substance having H is a hydrocarbon.

114. The plasma processing method according to claim 113, wherein the hydrocarbon is CH_4.

115. The plasma processing method according to claim 112, wherein the substance having H is H_2.

116. The plasma processing method according to claim 112, wherein the substance having H is a hydrofluorocarbon.

117. The plasma processing method according to claim 116, wherein the number of H atoms relative to the number of F atoms is three or more in the hydrofluorocarbon.

118. The plasma processing method according to claim 117, wherein the hydrofluorocarbon is CH_3F.

119. The plasma processing method according to

claim 118, wherein a ratio of a flow rate of the CH_3F relative to a flow rate of the substance having C and F is set at 0.04 to 0.07 in the etching gas.

120. The plasma processing method according to claim 112, wherein the substance having C and F is CF_4.

121. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the etching objective portion, and a mask layer covering the antireflective layer and having an opening pattern formed therein;

turning an etching gas containing a substance having C and F, and a hydrocarbon into plasma in the process container, and etching the antireflective layer through the opening pattern; and

etching the etching objective portion.

122. The plasma processing method according to claim 121, wherein the hydrocarbon is CH_4.

123. The plasma processing method according to claim 121, wherein the substance having C and F is CF_4.

124. The plasma processing method according to claim 121, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

125. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the etching objective portion, and a mask layer covering the antireflective layer and having an opening pattern formed therein;

turning an etching gas into plasma in the process container, and etching the antireflective layer through the opening pattern, wherein the etching gas contains a substance having C and F, and a substance having C, H, and F in which the number of H atoms relative to the number of F atoms is three or more; and

etching the etching objective portion.

126. The plasma processing method according to claim 125, wherein the substance having C, H, and F in which the number of H atoms relative to the number of F atoms is three or more is CH_3F.

127. The plasma processing method according to claim 125, wherein the substance having C and F is CF_4.

128. The plasma processing method according to claim 127, wherein a ratio of a flow rate of the CH_3F relative to a flow rate of the substance having C and F is set at 0.04 to 0.07 in the etching gas.

129. The plasma processing method according to claim 125, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

130. A plasma processing method comprising the

steps of:

placing a process subject in a process container, wherein the process subject has an etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the etching objective portion, and having an opening pattern formed therein;

turning a process gas containing a substance having C and F, and CO into plasma in the process container, and irradiating the photoresist layer with the plasma; and

turning an etching gas into plasma in the process container, and etching the etching objective portion by the plasma of the etching gas through the opening pattern.

131. The plasma processing method according to claim 130, wherein the substance having C and F is CF_4.

132. The plasma processing method according to claim 130, wherein the process gas and the etching gas are the same gas.

133. The plasma processing method according to claim 132, wherein the etching objective portion is an antireflective layer.

134. A plasma processing method comprising:

a step of placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the

etching objective portion, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the antireflective layer, and having an opening pattern formed therein;

a first etching step of turning a first etching gas containing a substance having C and F, and CO into plasma in the process container, and etching the antireflective layer by the plasma through the opening pattern; and

a second etching step of turning a second etching gas into plasma in the process container, and etching the etching objective portion by the plasma of the second etching gas through the opening pattern.

135. The plasma processing method according to claim 134, wherein the substance having C and F is CF_4.

136. The plasma processing method according to claim 134, wherein the etching objective portion is an SiO_2 layer, and the second etching gas contains C_5F_8.

137. The plasma processing method according to claim 134, wherein the etching objective portion is an SiO_2 layer, and the second etching gas contains C_4F_6.

138. A plasma processing method comprising:

a step of placing a process subject in a process container, wherein the process subject has an etching objective portion, an antireflective layer covering the etching objective portion, and a mask layer covering the antireflective layer and having an opening pattern

formed therein;

a first etching step of turning a first etching gas containing CF_4 and CO into plasma in the process container, and etching the antireflective layer by the plasma through the opening pattern; and

a second etching step of turning a second etching gas into plasma in the process container, and etching the etching objective portion by the plasma of the second etching gas through the opening pattern.

139. The plasma processing method according to claim 138, wherein the etching objective portion is an SiO_2 layer, and the second etching gas contains C_4F_6.

140. The plasma processing method according to claim 139, wherein the etching objective portion is an SiO_2 layer, and the second etching gas contains C_5F_8.

141. A plasma processing method comprising the steps of:

placing a process subject in a process container, wherein the process subject has an etching objective layer, an organic antireflective layer covering the etching objective layer, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the organic antireflective layer, and having an opening pattern formed therein;

supplying an etching gas containing a substance having Si into the process container; and

turning the etching gas into plasma, and etching

the organic antireflective layer through the opening pattern of the photoresist layer.

142. The plasma processing method according to claim 141, wherein the substance having Si is SiF_4.

143. The plasma processing method according to claim 142, wherein the etching gas contains CHF_3.

144. The plasma processing method according to claim 142, wherein the etching gas contains HBr.

145. The plasma processing method according to claim 142, wherein the etching gas contains He.

146. The plasma processing method according to claim 142, wherein the etching gas contains H_2.

147. The plasma processing method according to claim 141, further comprising a step of plasma-etching the etching objective layer through the opening pattern of the photoresist layer after the step of etching the organic antireflective layer.

148. A plasma processing method comprising the steps of:

placing a process subject on a susceptor disposed in a process container, wherein the process subject has an etching objective layer, and a mask layer covering the etching objective layer and having an opening pattern formed therein;

supplying an inert gas into the process container in a state where the process subject and a member having a surface at least a part of which is made of Si

are present in the process container;

supplying the process container with high-frequency energy to ionize at least a part of the inert gas;

supplying an etching gas into the process container;

turning the etching gas into plasma; and

etching the etching objective layer by the plasma of the etching gas through the opening pattern of the mask layer in the process container.

149. The plasma processing method according to claim 148, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

150. The plasma processing method according to claim 148, wherein the member having a surface at least a part of which is made of Si is a focus ring disposed around the process subject.

151. The plasma processing method according to claim 148, wherein the member having a surface at least a part of which is made of Si is a showerhead disposed to supply the etching gas into the process container.

152. The plasma processing method according to claim 148, wherein the etching objective layer consists of Si oxide, and the etching gas contains at least one selected from the group consisting of C_4F_6, C_4F_8, and C_5F_8.

153. The plasma processing method according to claim 148, further comprising a step of plasma-removing

the mask layer by a plurality of stages, after the etching step.

154. The plasma processing method according to claim 153, wherein the step of plasma-removing the mask layer by a plurality of stages comprises a first removing step of removing a part of the mask layer by plasma of a gas containing a fluorine compound, and a second removing step of removing at least a part of the mask layer left by the first removing step, by plasma of a gas containing no fluorine compound.

155. The plasma processing method according to claim 154, wherein the mask layer is an ArF photoresist layer, and the gas used in the first removing step is CF_4.

156. The plasma processing method according to claim 148, wherein the step of supplying the process container with energy comprises application of a high-frequency power to an antenna disposed outside the process container.

157. The plasma processing method according to claim 148, wherein the step of supplying the process container with energy comprises application of a high-frequency power to a counter electrode disposed in the process container to face the susceptor.

158. A plasma processing method comprising the steps of:

placing a process subject on a susceptor disposed

in a process container, wherein the process subject has an etching objective layer, and a mask layer covering the etching objective layer and having an opening pattern formed therein;

forming a Si-containing layer on a surface of the mask layer in the process container;

supplying an etching gas into the process container;

turning the etching gas into plasma; and

etching the etching objective layer by the plasma of the etching gas through the opening pattern of the mask layer in the process container.

159. The plasma processing method according to claim 158, further comprising a step of plasma-removing the mask layer by a plurality of stages, after the plasma etching step.

160. The plasma processing method according to claim 159, wherein the step of plasma-removing the mask layer by a plurality of stages comprises a first removing step of removing a part of the mask layer by plasma of a gas containing a fluorine compound, and a second removing step of removing at least a part of the mask layer left by the first removing step, by plasma of a gas containing no fluorine compound.

161. The plasma processing method according to claim 160, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer, and the gas used in the

first removing step is CF_4.

162. The plasma processing method according to claim 158, wherein the mask layer is an ArF photoresist layer or F2 photoresist layer.

163. The plasma processing method according to claim 158, wherein the etching objective layer consists of Si oxide, and the etching gas contains at least one selected from the group consisting of C_4F_6, C_4F_8, and C_5F_8.

164. The plasma processing method according to claim 158, wherein the step of forming an Si-containing layer is performed by a PVD method.

165. The plasma processing method according to claim 158, wherein the step of forming an Si-containing layer is performed by a CVD method.

166. A plasma processing method comprising the steps of:

preparing a process container such that a member having a surface at least a part of which is made of Si, a first electrode, and a second electrode facing the first electrode are disposed in the process container;

placing a process subject on the first electrode disposed in the process container, wherein the process subject has an etching objective layer, and a mask layer covering the etching objective layer and having an opening pattern formed therein;

supplying an inert gas into the process container;

applying a high-frequency power to the first

electrode;

applying a high-frequency power to the second electrode;

supplying an etching gas into the process container; and

etching the etching objective layer by the etching gas turned into plasma by the high-frequency powers through the opening pattern of the mask layer in the process container.

167. The plasma processing method according to claim 166, wherein member having a surface at least a part of which is made of Si is an electrode plate of the second electrode.

168. The plasma processing method according to claim 166, further comprising a step of plasma-removing the mask layer by a plurality of stages after the plasma etching step.

169. A plasma processing method comprising the steps of:

placing a process subject on a susceptor disposed in a process container, wherein the process subject has an etching objective layer, and a photoresist layer made of an ArF photoresist or F2 photoresist, covering the etching objective layer, and having an opening pattern formed therein;

supplying an etching gas containing an Si compound into the process container;

turning the etching gas into plasma; and

etching the etching objective layer by the plasma of the etching gas through the opening pattern of the photoresist layer in the process container.

170. The plasma processing method according to claim 169, wherein the Si compound is SiF_4.